Detection of adsorbates on interior surfaces of holey fibers

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part (CIP) of copending U.S. Application Serial Number 10/317,744 filed 12/12/02 (now patent 6,661,957 issued 12/09/03) which was a continuation-in-part (CIP) of copending U.S. Application Serial Number 09/907,241 filed 7/17/01 (now US Patent 6,496,634 issued 12/17/02), the above applications being incorporated herein by reference in their entirety including incorporated material.

FIELD OF THE INVENTION

The field of the invention is the field of optical fibers for the conduction of electromagnetic radiation, wherein the fibers have holes running along the fiber axis.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross sectional view of a "holey" optical fiber of the invention.

Fig. 2 is a sketch of the system of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Copending U.S. Application Serial Number 10/317,744 filed 12/12/02 (now patent 6,661,957 issued 12/09/03) and its parent application 09/907,241 filed 7/17/01 (now US Patent 6,496,634 issued 12/17/02), included a detailed description of an optical fiber having fluid filled holes for Raman amplification of light. Fig. 1 shows a sketch of a cross section of the optical fiber 10 of the invention. The fiber 10 comprises a core region 12 and a transparent cladding region 14 surrounding the core region. The core region contains a plurality of holes 16 elongated in the axial direction of the fiber. The core region may or may not contain a central hole region 18. The walls of at least one hole or the central region have an optically active

material 17 adsorbed on to the wall.

Optical fibers will have a useful life measured in decades, and the material of the cladding 14 is usually fused silica.

When light is propagated down the fiber 10, it will propagate a great distance with high power. If the optically active material 17 is a Raman active material, Raman light will be generated and will also propagate down the axis of the fiber or may escape through the transparent walls of the fiber. The Raman light may be detected and thus the presence of the Raman active material may be detected.

Similarly, if the adsorbed material is an infrared, visible, or ultraviolet active material, light propagating down the optical fiber will be absorbed or scattered or fluoresced, and the presence of the material can be detected by detectors placed either at the output of the axis of the fiber or at the side of the fiber.

It is well known that molecules adsorbed on surfaces often have a much enhanced Raman cross section. Polar molecules such as air pollutants carbon monoxide, nitrogen oxide, and nitrogen dioxide are particularly preferred embodiments of the invention. Detection of biothreat materials such as bacteria and nerve gas material are also preferred embodiments of the invention. For purposes of investigation of relatively large entities like bacteria, the central hole region 18 may be much larger than the core region of a single mode optical fiber.

The method of the invention comprises introducing optically active molecules or other entities into the hollow core region 18 or into the holes 16 of the holey fiber, and propagating light down the axis of the core. The light will be guided by the holey fiber, and the intensity and interaction length will be much larger than if the light is merely focused in a gas or other fluid medium. It is well known that optically active molecules like carbon monoxide or nitrous oxide can be made to "stick" to either the clean walls of the holes or to specially prepared material of the walls.

Fig. 2 shows a sketch of the system of the invention. Light output from one or more lasers or other sources of light 22 is introduced into the fiber of the invention 20 by an optical apparatus 24 as is known in the art. Optical apparatus 26 is used to conduct light from the fiber 20 to detectors, spectral analysis units, signal splitters, demodulators, etc 28 as are known in the

art. Control apparatus 26 controls the light generator 22 and optical apparatus 24 and communicates with detectors etc. 28.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.